# American POTATO JOURNAL

*Volume 31* · *August 1954* *Number 8*

## CONTENTS

Late Blight in Mexico—*John S. Niederhauser, Javier Cervantes, and Leopoldo Servin* ..... 233

Relationship of Potato Races to *Phytophthora infestans* and Genes for Resistance—*Anon* ..... 238

Minutes of the Late Blight Committee of The Potato Association of America—*Anon* ..... 240

Unilateral Effects Caused by Varied Nutrition of Potato Roots —*G. V. C. Houghland* ..... 242

Results of Potato Seed-Piece Treatment Tests in Kern County, California—*John L. Nickel* ..... 245

### POTATO NEWS AND REVIEWS

New Developments in Potato Handling Machinery—*T. J. Lockwood* ..... 252

Program of the Annual Meeting of The Potato Association of America ..... 260

*Official Organ of*

**THE POTATO ASSOCIATION OF AMERICA**

**NEW BRUNSWICK, NEW JERSEY**

# Potash and Potatoes

Growing potato plants will show their need for potash by leaves that have an unnatural, dark green color and become crinkled and somewhat thickened. Later on, the tip will become yellowed and scorched. This tipburn then will extend along the leaf margins and inward toward the midrib, usually curling the leaf downward and resulting in premature dying. It pays to watch for these signs, but it is far better practice to fertilize with enough potash so as never to give them a chance to appear.

**AMERICAN POTASH INSTITUTE, INC.**

1102 Sixteenth St., N. W. Washington 6, D. C.

Member Companies: American Potash & Chemical Corporation • Duval Sulphur & Potash Company • Potash Company of America • Southwest Potash Corporation • United States Potash Company

Boggs

## THE "STANDARD"
## Potato and Onion Grader

*Not only "STANDARD" but "SUPERIOR" in Economy, Accuracy, Speed, and Adaptability.*

More Boggs Graders in use than all other makes combined—there must be a reason. Send for our new circular and price list.

## BOGGS MFG. CORP., Atlanta, N. Y.

## Fast-Reading EXACT WEIGHT Scales Speed Potato Packaging, Boost Profits

With a fast-weighing, fast-reading EXACT WEIGHT Scale, one operator can package, weigh, and check — all in one operation. An adjustable damping device brings scale indicator to rest quickly, and magnified indication enables operator to make an accurate reading at a glance. The seconds clipped off each weighing operation plus the saving from elimination of over-weights add dollars to your profits. In an astonishingly short time the savings can pay for the installation. Write for complete details.

There is no substitute for Exact Weight

Exact Weight Scales

*Better quality control*

*Better cost control*

**THE EXACT WEIGHT SCALE COMPANY**

**921 W. Fifth Avenue, Columbus 8, Ohio**
**2920 Bloor St. W., Toronto 18, Canada**

# American Potato Journal

PUBLISHED BY
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, N. J.

EXECUTIVE COMMITTEE

WM. H. MARTIN, *Editor*
E. S. CLARK, J. C. CAMPBELL, *Associate Editors*
Rutgers University, New Brunswick, N. J.

J. W. SCANNELL, *President* .....Department of Agriculture, Ottawa, Canada
ARTHUR HAWKINS, *Vice President* .....University of Connecticut, Storrs, Conn.
R. W. HOUGAS, *Secretary* .....University of Wisconsin, Madison, Wis.
JOHN C. CAMPBELL, *Treasurer* .....Rutgers University, New Brunswick, N. J.
J. H. MUNCIE, *Past President* .....Michigan State College, East Lansing, Mich.
CECIL FRUTCHEY, *Director* .....Colorado A & M College, Ft. Collins, Colo.
N. M. PARKS, *Director* .....Department of Agriculture, Ottawa, Canada
PAUL EASTMAN, *Director* .....Department of Agriculture, Augusta, Maine

**Price $4.00 per year in North America**
**$5.00 in other countries after January 1, 1954**

Entered as second class matter at New Brunswick, N. J., March 14, 1942 under Act of March 3, 1879. Accepted for mailing at special rate of postage provided for in section 412, Act of February 28, 1925, authorized on March 14, 1928.

---

## SUSTAINING MEMBERS

THE DOW CHEMICAL CO. .....Midland, Michigan
STARKS FARMS INC. .....Route 3, Rhinelander, Wisconsin
BACON BROTHERS .....1425 So. Racine Ave., Chicago 8, Illinois
L. L. OLDS SEED CO. .....Madison, Wisconsin
FRANK L. CLARK, Founder — Clark Seed Farms .....Richford, New York
RED DOT FOODS, INC. .....Madison, Wisconsin
INTERNATIONAL HARVESTER CO. .....Chicago, Illinois
ROHM & HAAS COMPANY .....Philadelphia, Pennsylvania
CALUMET DIVISION, CALUMET & HECLA, INC. .....1 Calumet Ave., Calumet, Michigan
WISE POTATO CHIP CO. .....Berwick, Pennsylvania
JOHN BEAN DIVISION, FOOD MACHINERY CORP. .....Lansing 4, Michigan
S. KENNEDY & SONS, Growers and Shippers of Potatoes and Onions ..Clear Lake, Iowa
MATHIESON CHEMICAL CORP. .....Mathieson Bldg., Baltimore, 3, Maryland
AMERICAN AGRICULTURAL CHEMICAL CO. .....Carteret, New Jersey
GREEN CROSS INSECTICIDES .....Montreal, Canada

We welcome the above firms as sustaining members and express to them our appreciation for their interest and financial support.

# LATE BLIGHT IN MEXICO[1]

JOHN S. NIEDERHAUSER[2], JAVIER CERVANTES[3], AND LEOPOLDO SERVIN[3]

Central Mexico has long been known as an area rich in wild tuber-bearing species of *Solanum*. Since many of these species have proved to be resistant to *Phytophthora infestans* (Mont.) D.By., plant breeders attempting to incorporate late-blight resistance into a commercial potato variety have always been interested in collections made in this area. One species in particular, *Solanum demissum* Lindl., has been the subject of intense study, and the resistance genes found in certain clones of this species have been widely used in potato breeding programs in Europe and North America. The attractive possibility of attaining blight immunity by using *S. demissum* as a source of resistance has postponed an active interest in the other blight-resistant species from Central Mexico. Only in the last few years have we learned that earlier successes were temporary, and that resistance to *P. infestans* was not to be gained so easily. It has been found there are a number of races of the pathogen, and that the appearance of a new race usually depends upon the presence of a suitable resistant seedling which only the new race could attack. The history of a succession of "resistant" varieties that soon became susceptible is eloquent testimony to this changing race picture.

Until very recently, that which was known about the resistance of the wild species to *P. infestans* was limited to the results of exposing selected clones of these species to the available races of the pathogen isolated in Europe, Canada, and the United States. It is therefore particularly important to know more about the resistance of the wild species in their native habitat. The level of resistance that they have attained here during a long association with *P. infestans* may indicate the ultimate level of resistance that we can hope for in a breeding program. In 1952 it was shown that most of these *Solanum* species, some of which had been reported to be immune, are susceptible to certain naturally occurring races of *P. infestans* in Central Mexico (2). There is an obvious need for more information about the resistance of these species to the more specialized races.

Certain clones of the *Solanum* species have maintained a high level of blight resistance that has definite survival value in an environment so favorable to blight. This is an encouraging fact, and prompts us to investigate thoroughly the nature and limits of this resistance that has persisted in nature despite a long association with the pathogen. The more we know about this resistance, the better we can devise proper screening trials for selecting our resistant material, and the greater is our chance for ultimate success.

---

[1]Accepted for publication March 8, 1954.
Journal Series Paper No. 13 of the Mexican Agricultural Program of The Rockefeller Foundation. Paper presented at the Late Blight Symposium sponsored by the Potato Association of America at its annual meeting held in Madison, Wis., on September 7, 1953.

[2]Plant Pathologist with the Mexican Agricultural Program of The Rockefeller Foundation.
[3]Ingeniero Agronomo with the Oficina de Estudios Especiales, Secretaria de Agricultura y Ganaderia, Mexico, D.F.

Little attention has been given to the races of *P. infestans* prevalent in Central Mexico where the resistant *Solanum* species are found. In this region where climatic conditions annually favor late blight, resistant clones have provided the necessary suscepts for the selection and propagation of new races of the pathogen. These races might be expected to be highly specialized, and such has proved to be the case (1).

Specialized races of *P. infestans* have been found in breeding plots in many parts of the world. In certain areas a specialized race may become prevalent because of the extensive planting of a resistant variety.[4] Central Mexico is unique only because several of the most highly specialized races are among the prevalent field races. In other words, the race picture in Central Mexico is a preview of what can be expected in other places where and when resistant selections are made and increased for commercial production.

In 1948 several named varieties developed by Dr. Reddick at Cornell University were planted in the Valley of Mexico where they promptly blighted and died. This was the first evidence of the prevalence of specialized races of *P. infestans* in Mexico. These varieties carried the single major gene for resistance to late blight that Drs. Reddick, Mills, and Peterson have designated as "D" and that Dr. Black has called "$R_1$."

In 1949 and 1951 other varieties, including Kennebec, were tested and met a similar fate. In 1952 Dr. Mills brought to Mexico 143 clones with "CD" genes for resistance (Dr. Black's "$R_1R_2$"), which up to that time had been resistant in all trials made with the available races in the United States. When planted in the field in the Valley of Toluca, near Mexico City all plants developed blight and most were killed outright. But a marked variation in susceptibility was noted, and "tolerant" or "partially resistant" selections were kept for further trials. This variation in susceptibility suggested the importance of genes other than those which were common to all of the clones ("$R_1R_2$").

In 1953 nearly 4,000 lines were tested in the field near Toluca. Most of these lines were furnished by Dr. F. J. Stevenson of the United States Department of Agriculture, and a lesser number by Drs. Krantz and Eide of the University of Minnesota. These lines either had survived the blight screening given them in the U.S.D.A. trials or had shown some level of resistance at Minnesota. Only six weeks after planting, 94 per cent of these seedlings had been severely blighted or killed. The remaining 6 per cent showed varying degrees of resistance, although none was completely free from attack. It is significant that isolates of the pathogen from these resistant plants were not always the most highly specialized races. It was apparent that a high level of field resistance was present in some of these seedlings, and that this resistance was due only in part to the major gene resistance for which they had been selected. There was a valuable reservoir of minor gene resistance in these resistant seedlings which we were discovering only by field tests where a number of highly specialized races were prevalent.

In the course of making these field observations on resistant seedling lines, about 90 cultures of *P. infestans* from a wide variety of sources have been isolated. A number of these isolates have been identified on

[4]For example, Race 1 in the United States where Essex and Kennebec, both with "$R_1$" resistance, have been planted commercially.

the series of differential varieties developed by Dr. Black, and also on those developed in the United States by Drs. Reddick, Mills, and Peterson (Table 1). A close correlation between the two sets of differentials was soon apparent. The three genes for resistance found in the United States had their counterparts in the system of Dr. Black, who had discovered an additional fourth gene.

TABLE 1.—*Races of P. infestans isolated in Mexico.*

| Black | U. S. | International |
|---|---|---|
| A | A | 0 |
| $B_1$ | D | 1 |
| $B_2$ | BD | 1,4 |
| C | BC | 2,4 |
| D | B | 4 |
| E | — | 1,3 |
| F | — | 1,3,4 |
| G | CD | 1,2 |
| H | C | 2 |
| I | — | 3,4 |
| J | — | 3 |
| — | BCD | 1,2,4 |
| — | — | 2,3,4 |
| — | — | 1,2,3,4 |
| — | — | 1,2,3,4,5 (?) |

Some of the more highly specialized isolates blighted all of the differentials used in both systems. These cultures were isolated originally from lesions on wild clones of *Solanum demissum* and also from blighting seedling lines under observation in field plots. These highly specialized isolates have been separated into two groups, based on their ability to attack certain clones of *S. demissum*. One group infects all of the differentials, but does not infect *S. demissum* clone S-74. This might be the basis for some hope of attaining immunity, were it not for the fact that the second group of isolates[5] is able to attack not only all of the differentials but also the *S. demissum* clone S-74. This clone apparently possesses a fifth gene for resistance, previously unreported. To date no clone of *S. demissum* has been found to be resistant to these most highly specialized isolates.

[5]In table 1 this group of isolates is identified provisionally as race 1,2,3,4,5 (International System).

Our experience with other Mexican tuber-bearing species of *Solanum* has shown that nearly all of them will blight rather freely, but several levels of resistance are apparent. One clone of *Solanum bulbocastanum* to date has remained blight-free. Unfortunately we have not been able to cross this clone of a diploid species with other varieties and species available. The triploid form of *Solanum cardiophyllum* Lindl. has been highly resistant. A culture of *P. infestans* was isolated from this species with great difficulty. This isolate incited small, necrotic lesions, which were the only symptoms observed in the field. But here also we have failed in all of our efforts to make crosses with this triploid form.

The prospects of obtaining a blight-resistant commercial potato might appear rather remote. As data and observations accumulate, it is apparently unlikely that blight immunity exists in the tuber-bearing species of *Solanum*. If such is the case, the alternative is to look for the highest possible level of resistance and try to incorporate this resistance into a commercial potato. Several species, including some clones of *S. demissum*, show a high resistance to *P. infestans* even though foliage lesions are produced on them. These resistant-type lesions are slow spreading, often turn necrotic, and sporulation is sparse. Petiole and stem lesions tend to be superficial and do not kill the distal portions of the affected leaf or stem. Relatively few lesions develop on a plant, and these are more often on the lower, older leaves. This type of resistance we have called "partial resistance." Some have called it "field resistance" or "tolerance." A high level of "partial resistance" is due to major genes, aided by a number of the so-called minor genes which condition the response of a given plant to the races to which it is susceptible.

Sometimes a variety such as Sebago may have the proper combination of minor genes to show a slight degree of resistance to all races, even though in another sense it is susceptible to all races, including the common field race "O." A somewhat higher level of partial resistance is demonstrated by the European varieties Alpha, Gineke, Voran, and Ostbote. All such varieties can be killed by heavy inoculations with the common field race "O." In the field, however, they show a degree of resistance that is exhibited equally toward all races of the pathogen. These "field-resistant" varieties remain green longer than varieties without this partial resistance. The practical value of the resistance lies in the fact that these varieties can be sprayed less thoroughly and less often and still be adequately protected against blight. It is the partial resistance of these European varieties that we are exploiting in our commercial potato program in Mexico. We are able to control blight very effectively on these varieties, whereas more susceptible varieties are extremely difficult to maintain free from blight.

An important objective of our potato improvement program is to develop a commercially acceptable potato with a high level of partial resistance, so that fewer sprays are needed for blight control. We have species, such as *S. demissum* and *S. iopetalum* (Bitt.) Hawkes, that show a very high level of partial resistance and that can be crossed directly with commercial varieties of *S. tuberosum*. If this partial resistance could be maintained in a more commercial type potato, blight-control sprays might be unnecessary.

A second kind of resistance, which might be called "racial resistance,"

is due solely to the presence of one or more of the major genes for resistance. Dr. Black has described four of these genes, and we have demonstrated that a fifth gene probably exists and perhaps there are more. When these genes are present singly or in combination, they confer resistance to certain specific races. However, in Mexico field experience has shown repeatedly that racial resistance alone is not of much value. The history of many "resistant" potato varieties released in other countries supports our doubts as to the value of strictly "racial resistance"; once the varieties become fairly well distributed, they begin to blight. We believe that resistance based solely on single major genes, or on combinations of single major genes, is of very temporary value in blight control and does not offer as much promise of permanent, practical benefit as does the partial resistance.

This is not to imply that the major genes are not of great importance, for they are. It is possible that the high level of partial resistance shown by certain clones of the hexaploid species *S. demissum* is due to the functioning of two or more major genes as multiples. A seedling from one of Dr. Reddick's crosses, DFR-4, is a duplex "DD" or "$R_1R_1$" plant. It will tolerate very severe late-blight exposure in the field and still produce a crop. Although its blight resistance is not all that can be desired, it suggests that further improvement can be obtained by incorporating still other major genes, if possible also in the duplex condition. In this way perhaps we can approximate the high level of "partial resistance" to all races shown by *S. demissum*.

To find seedlings with this resistance, whether due to minor genes or major genes or a combination of both, selections should be made in the field, if possible where the most highly specialized races are prevalent. In this way, one can eliminate all plants with simple major gene resistance and select for further breeding work only those that meet rigorous standards for partial blight resistance in the field.

## Literature Cited

1. Mills, W. R. and John S. Niederhauser. 1953. Observations on races of *Phytophthora infestans* in Mexico. Phyt. 43: 454-455.
2. Niederhauser, John S. and W. R. Mills. 1953. Resistance of *Solanum* species to *Phytophthora infestans* in Mexico. Phyt. 43: 456-457.

## RELATIONSHIP OF POTATO RACES OF *Phytophthora infestans* AND GENES FOR RESISTANCE[1]

In breeding for resistance to potato late blight Dr. W. Black in Scotland found physiologic races of *P. infestans* and labeled them by letters of the alphabet. In the United States Drs. W. R. Mills and L. C. Peterson also found physiologic races of the fungus and likewise used the alphabet system. In Holland, Dr. C. Mastenbroek found physiologic races and used a letter-number system to designate them ($N^1$, $N^2$, *etc*). All of these workers found the new races appearing on clones bred from *Solanum demissum*. These workers found from three to four independent dominant genes for resistance and again used different schemes for designating these genes and gene combinations.

Since these different systems were creating confusion, the above-named workers exchanged differential hosts for comparative tests with their different races of the fungus. The results of this joint effort were published in the Holland journal, Euphytica 2: 173-179, 1953.

The following table is based on their results as brought out by Black, Peterson and Mills in the discussion following the Potato Late Blight Symposium held by the Potato Association of America at the 1953 meetings in Madison, Wisconsin.

Note that the genes for resistance match up as well as do the races of the potato late blight fungus. Also note that a new international system of designating these genes and races is proposed.

The new system assigns the number zero (0) to the common field race formerly designated as races A or $N_1$. The recessive genotypes are susceptible to this race. The numbers 1, 2, 3, and 4 were assigned to the races appearing on the single gene genotypes $R_1$, $R_2$, $RR_3$, and $R_4$: the numbers (1,2), (1,3), (1,4), (2,3), (2,4), and (3,4) were assigned to races appearing on the double genotypes $R_1R_2$, $R_1R_3$, $R_1R_4$, $R_2R_3$, $R_2R_4$, and $R_3R_4$; *etc*. These races are correctly designated as races one, one-two, one-two-three, *etc*., rather than races one, twelve, and one hundred twenty-three, *etc*.

This table is published at this time to familiarize potato workers with the new system and to tie in the new system with the Late Blight Symposium papers published in preceding issues of the American Potato Journal.

*The Committee on Late Blight Investigation*
*The Potato Association of America*

---

[1]Accepted for publication January 22, 1954.

## INTERNATIONAL SYSTEM OF DESIGNATING INTERRELATIONSHIPS OF GENES AND RACES

| GENOTYPE | | | | RACES OF *P. infestans* | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scotland | | | | A | $B^1$ | H | J | D | G | E | $B^2$ | - | C | I | - | - | F | - | - |
| U.S.A. | | | | A | D | C | - | B | - | - | BD | - | BC | - | - | - | - | - | - |
| Holland | | | | N1 | N2 | N5 | - | N4 | - | - | N7 | - | N6 | - | - | N8 | - | N9 | - |
| International* | | | | 0 | 1 | 2 | 3 | 4 | 1,2 | 1,3 | 1,4 | 2,3 | 2,4 | 3,4 | 1,2,3 | 1,2,4 | 1,3,4 | 2,3,4 | 1,2,3,4 |
| r | r | r | r | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S |
| $R_1$ | D | $R_9$ | $R_1$ | - | S | - | - | - | S | S | S | - | - | - | S | S | S | - | S |
| $R_2$ | C | $R_7$ | $R_2$ | - | - | S | - | - | S | - | - | S | S | - | S | S | - | S | S |
| $R_3$ | - | $R_8$ | $R_3$ | - | - | - | S | - | - | S | - | S | - | S | S | - | S | S | S |
| $R_4$ | B | $R_{2,5}$ | $R_4$ | - | - | - | - | S | - | - | S | - | S | S | - | S | S | S | S |
| $R_1R_2$ | CD | - | $R_1R_2$ | - | - | - | - | - | S | - | - | - | - | - | S | S | - | - | S |
| $R_1R_3$ | - | - | $R_1R_3$ | - | - | - | - | - | - | S | - | - | - | - | S | - | S | - | S |
| $R_1R_4$ | BD | - | $R_1R_4$ | - | - | - | - | - | - | - | S | - | - | - | - | S | S | - | S |
| $R_2R_3$ | - | - | $R_2R_3$ | - | - | - | - | - | - | - | - | S | - | - | S | - | - | S | S |
| $R_2R_4$ | BC | - | $R_2R_4$ | - | - | - | - | - | - | - | - | - | S | - | - | S | - | S | S |
| $R_3R_4$ | - | - | $R_3R_4$ | - | - | - | - | - | - | - | - | - | - | S | - | - | S | S | S |
| $R_1R_2R_3$ | - | - | $R_1R_2R_3$ | - | - | - | - | - | - | - | - | - | - | - | S | - | - | - | S |
| $R_1R_2R_4$ | BCD | - | $R_1R_2R_4$ | - | - | - | - | - | - | - | - | - | - | - | - | S | - | - | S |
| $R_1R_3R_4$ | - | - | $R_1R_3R_4$ | - | - | - | - | - | - | - | - | - | - | - | - | - | S | - | S |
| $R_2R_3R_4$ | - | - | $R_2R_3R_4$ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | S | S |
| $R_1R_2R_3R_4$ | - | - | $R_1R_2R_3R_4$ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | S |

*Races (2,3), (1,2,3) and (1,2,3,4) have not been found in the above mentioned three countries but appear to be present in Canada and Mexico.

— = Resistance, S = Susceptible

# MINUTES OF THE LATE BLIGHT COMMITTEE OF THE POTATO ASSOCIATION OF AMERICA

The committee on Late Blight of The Potato Association of America met during the morning of September 8, 1953, in the Mechanical Engineering Building on the campus of the University of Wisconsin. The members of the committee were M. E. Gallegly, C. J. Eide, W. R. Mills, L. C. Peterson and J. S. Neiderhauser. Others invited to attend the meeting were W. A. Hodgson (Fredericton, N. B., Canada), who represented committee member J. L. Howatt, and R. V. Akeley and F. J. Stevenson of the United States Department of Agriculture.

As a general item of business the committee decided that the president of the association be asked to appoint R. V. Akeley as a member of the Late Blight Committee representing the United States Department of Agriculture.

Regarding future actions of the committee the following items were discussed:

1. It was suggested that the committee could be instrumental in selecting homozygous *Solanum demissum* lines representing the different genotypes (a recessive susceptible line, and lines homozygous for single genes and for genes in combination). It was pointed out that many of these genotypes may be present in the collection of *S. demissum* maintained at Sturgeon Bay, Wisconsin. It was also pointed out that only five genotypes, recessive, $R_1$, $R_2$, $R_3$ and $R_4$, would be needed to identify races of the late blight fungus, providing the isolate in question was not a mixture of two or more races.

2. A second suggestion was that one station keep a pure culture of the various *P. infestans* races. These are to be kept in a virulent state and genetically pure. Distribution of these races to be cleared with the Bureau of Entomology and Plant Quarantine and the Committee so that the more advanced races would be placed only in the hands of competent individuals. This would be necessary to reduce the chance of escape of these fungous races into outdoor potato culture.

3. It was also suggested that the Bureau of Entomology and Plant Quarantine be asked for clearance to import various races of *P. infestans* as necessary working tools in the late-blight breeding programs. It was pointed out that the blight situation in Mexico may be a preview of the future race situation in North America. If those races occurring in Mexico (reported to be virulent on all preesntly known genotypes) could be brought into this country for research purposes then a search for additional genes for resistance could be more effectively carried out. Without the proper races it would be difficult or impossible to find the additional resistance here. A similar search for other genes for resistance could be carried out by workers in Mexico, but it would be impractical for North American potato breeders to use this resistance in a breeding program without access to the proper races. It was noted, however, that should these races be brought in it would be necessary to use extreme caution in handling them so as not to allow them to escape and become established in nature. This would cut short the life of certain genotypes now grown commercially that are resistant to races occurring naturally in this country. It was noted that the more virulent races may eventually

appear naturally in this country but that we should not speed up their appearance by artificial means.

4. A fourth item dealt with the method of distributing cultures of races of the late blight fungus. It was noted that Gallegly had brought in isolates from Scotland and Holland under restrictions set down by the Bureau of Entomology and Plant Quarantine. It was directed that Gallegly request permission of the Bureau of Entomology and Plant Quarantine to send sub-cultures of these races to certain individuals. Those requesting cultures were Eide, Mills and Peterson. In addition, it was recommended that a letter requesting permission to bring in *P. infestans* isolates from Mexico, Canada and Europe be drafted and sent to the Bureau of Entomology and Plant Quarantine. W. R. Mills was asked to make the first draft of the letter. The cultures could be sent to one person (W. R. Mills) and be distributed to other workers by him. Those requesting isolates at present are C. J. Eide, University of Minnesota; W. R. Mills, Pennsylvania State College; L. C. Peterson, Cornell University; and M. E. Gallegly, West Virginia University.

It was stated for the information of the Committee by F. J. Stevenson that Paul Miller had some of the Mexican isolates and that we should start with these and then obtain additional races if necessary.

5. A fifth item of business dealt with preparation of a table showing the relationship of genes and races. It was directed that this table be published in the American Potato Journal as an anonymous supplement to the Symposium papers presented at the Madison meetings.

M. E. GALLEGLY, *Chairman*
*Late Blight Committee*
*Potato Association of America*

# UNILATERAL EFFECTS CAUSED BY VARIED NUTRITION OF POTATO ROOTS[1]

G. V. C. HOUGHLAND[2]

It is well known that the growth of potato vines can be markedly affected by altering the nutrient ratio of the fertilizer applied, particularly by altering the amount of nitrogen or potassium or both. Exploratory experiments, using a split-root technique with different solution cultures, were made to get some information about the effects of varied fertilization of the roots. A brief description of this technique and some preliminary results are given.

Potato seed pieces, covered with sphagnum moss, were sprouted on a wire-screen support held in place over a one-tenth strength normal nutrient solution. When the plants had reached a height of 7 to 10 cms. they were transferred to the two-solution apparatus. The roots were first washed in tap water and then divided so that approximately one-half of them was in each solution. The conductive tissue of the stem was not divided by cutting, as to do this was considered impracticable. Each solution was continuously aerated.

The most interesting results so far have been obtained with potassium. Potato plants with one-half their roots in a nutrient solution lacking only potassium and the remaining roots in a solution containing only potassium chloride developed marked differences in root and top growth. In the nutrient solution lacking potassium, root growth was relatively good, whereas growth in the potassium chloride solution was very poor. The plants developed distinct unilateral potassium deficiency symptoms. These symptoms (Figure 1) consisting of marginal necrotic areas and brown spots between the veins did not occur on all leaves but were confined to certain leaves and appeared on only one-half of some of the leaflets (Figure 1). Such results strongly suggest the existence of direct channels between roots and leaves of the potato plant, as are known to exist in fruit trees. Apparently there was little, if any, cross transfer of potassium in the plant. McMurtrey (1) noted the occurrence of unilateral deficiency symptoms of various elements in the tobacco plant, because of the absence of cross transfer of nutrients.

Plants grown in a similar two-solution experiment with one set of roots in a solution lacking only nitrogen showed no signs of unilateral deficiency symptoms in the tops. There was, however, a unilateral production of tuber stolons as illustrated in figure 2. In all cases where nitrate nitrogen alone was supplied to one set of roots, the initiation of tuber stolons was markedly retarded on that side. When potassium was omitted, either the number of tuber stolons was reduced or development was retarded.

[1]Accepted for publication December 20, 1953.

[2]Biochemist, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, Beltsville, Md.

## LITERATURE CITED

1. McMurtrey, J. E., Jr. 1937. Cross transfer of mineral nutrients in the tobacco plant. Jour. Agr. Res. 55: 475-482.

FIGURE 1.—Unilateral potassium deficiency symptoms on potato with potassium supplied to only one-half of the roots..

FIGURE 2.—Unilateral production of tuber stolons on potato plant with roots on left supplied with nitrate nitrogen and those on right supplied with nutrient solution minus nitrogen.

# RESULTS OF POTATO SEED-PIECE TREATMENT TESTS IN KERN COUNTY, CALIFORNIA[1]

JOHN L. NICKEL[2]

For some time it has been a common practice in Kern County to treat whole potato seed before planting; the common treatment being a two hour dip in 1:1000 mercuric chloride with the hope of killing common scab and *Rhizoctonia* on the surface while lessening the spread of bacterial diseases. Recently, however, several growers have inaugurated the practice of treating cut seed by passing it through a dipping vat on a conveyor belt between the cutting tables and the bagging platform. This study was undertaken to determine whether the chemicals being used or other chemicals available were favorable or detrimental to natural healing; also to ascertain whether any of these would be effective enough on surface fungi to warrant omitting the whole tuber dip in favor of a more efficient instantaneous dip, and to determine whether these chemicals are adequate enough as bactericides to prevent the dipping vat from becoming a vat of inoculum of such bacterial diseases as ring rot or blackleg. All tests reported were conducted with White Rose potatoes with the exception of the 1952 Spring trials in which Pontiac seed was employed.

## 1951 EXPERIMENTS

Preliminary investigations were conducted in the laboratory during the Spring of 1951 to screen various chemicals in order to determine their effect on the suberization process and, at the same time, determine their effect on surface fungi by using potatoes with *Rhizoctonia* sclerotia in the tests. Potatoes were cut, then immediately immersed in various concentrations of the chemicals. These pieces were then incubated in casserole moisture chambers at room temperature and observed at regular intervals for healing, presence of decay, and germination of the *Rhizoctonia* sclerotia Hand sections were also made at regular intervals, stained in Sudan IV, and examined microscopically for suberin deposit and periderm formation. Various lengths of immersion varying from 30 seconds to 5 minutes were tested, however little difference was noted due to immersion time, hence these results can be interpreted merely as being instantaneous dips.

A 5.0 per cent Zerlate solution materially enhanced suberization and periderm formation while also killing or greatly inhibiting germination of the *Rhizoctonia* sclerotia. Zerlate, 1.0 per cent; Fermate, 1.0; Fermate, 5.0; Phygon, 1.0; Ortho 406, 5.0; and Vancide 51, 1.0 per cent solutions differed very little in their effect on healing or *Rhizoctonia* growth from check treatments in which the seed pieces were dipped in water alone. Acidulated mercuric chloride (1:1000 $HgCl^2$ + 1.0 per cent HCl), Semesan Bel, 1.0 per cent and Roccal, 10.0 per cent killed or greatly inhibited *Rhizoctonia* germination, but resulted in serious decay due to interference with suberization. Roccal solutions of 0.2 and 0.4 per cent were detrimental to suberization while greatly enhancing *Rhizoctonia*

[1]Accepted for publication January 8, 1954.
All tests were conducted in Kern County, California with the exception of the Spring 1951 laboratory tests which were conducted in Berkeley, California while the author was a student at the University of Cal.
[2]Maple Leaf Farms Inc., Wasco, Cal.

growth. As Roccal is available in several concentrations, all dosages of this compound expressed in this paper are expressed in per cent alkyl-dimethyl benzyl ammonium chloride.

## Review of Literature

Many chemicals have been tested both in dips and as dusts to reduce seed-piece decay. Results have varied with the area and disease organism involved. Rich (11), in studies involving *Fusarium* seed-piece decay, found Phygon[1], Spergon, Zerlate, Arasan, and Orthocide 406 to give satisfactory control in inoculated soils, whereas good control was obtained with Semesan Bel, Phygon, Orthocide 406, and Manzate when seed pieces were dipped in a slurry of rotted potatoes prior to being treated and planted. Elmer (2), under Kansas conditions, found acidulated mercuric chloride as an instantaneous dip to be most effective in controlling seed-piece decay and *Rhizoctonia*. He noted no difference in this control when seed was treated as whole tubers or as cut seed pieces since the decay pathogen involved attacks mainly the uncut, outer surfaces. In British Columbia, Newton and Lines (8) found Fermate, Spergon, and Arasan effective in combatting *Pythium* rot of seed pieces; whereas hydrated lime, sulfur, Dithane, and Semesan Bel were found ineffective. Newton (7) also found Arasan and Spergon dusts effective against *Fusarium* decay. Sanford (12) similarly controlled *Fusarium* decay of seed pieces with Fermate and Spergon dust and Semesan Bel and Lunasan dips.

Newton (7) demonstrated that most treatments interfere with the natural healing processes to some extent by increasing moisture loss from the cut surfaces. Consequently, when decay organisms are not present, most treatments can be detrimental. Further, as demonstrated by Lane (5), these treatments are ineffective in improving stands under favorable growing conditions since these conditions permit untreated seed, though attacked by decay organisms, to produce relatively vigorous plants. Yet he found (6) that under adverse conditions thiuram and zineb reduced rot, improved stands, and increased yields significantly. The importance of various conditions on effectiveness of seed-piece treatment is further emphasized by the results of Olmstead (10), who found Zerlate, Zinc Oxide, Phygon, and Semesan Bel effective in controlling decay on Red Warba, Cobbler, and Pontiac. Identical tests conducted two weeks later found these same chemicals effective on Cobbler, but only Zerlate on Red Warba and Pontiac, the other treatments being detrimental to normal healing on the latter varieties.

Sanford (13) studied the effect of various chemicals on suberization. He found Spergon to aid suberization slightly, whereas Fermate and sulfur were slightly detrimental and the mercurials quite detrimental to suberization.

Young and Melbrath (15), in tests to prevent decay due to *Fusarium and Pythium*, found Semesan Bel, Phygon, and Ziram reduced seed-piece decay, reduced blackleg and *Rhizoctonia* incidence, and increased yield. Reduction of losses due to blackleg by seed treatment, in this case of whole tubers, has also been reported by Tucker and Harper (14).

With the Spring crop—the main crop in Kern County—potato seed-piece decay presents no problem, since conditions at planting time are optimum for good germination. The Fall crop, however, is planted in the

[1]Information on proprietory compounds used may be obtained in (3).

hot summer soil, and obtaining a good stand is one of the chief problems because of seed-piece decay. Therefore a plot was planted in the fall of 1951 to determine the effect on stand and yield of several treatments. Zerlate, which gave such favorable indications in the laboratory tests was used. Also Dithane Z-78 and Arasan were tested because they had been reported favorably in Colorado (6). Both 10 per cent dusts and one minute dips (1.0 per cent suspension of Zerlate, Dithane Z-78, and Arasan were tested. A 0.2 per cent Roccal dip was also included in the tests despite the unfavorable laboratory results, because of its current use in commercial practices.. Tubers were cut, treated, and planted the same day. Because of adverse soil conditions, results were too variable to be reported in detail, but in general results were favorable toward the zinc salts of the dithiocarbamates (Zerlate and Dithane Z-78). The Roccal treatment was significantly worse than the check, in fact it indicated that in a commercial practice, under similar conditions, this treatment would have resulted in crop failure.

## 1952 Experiments

Tests were conducted in the Spring crop of 1952 to determine whether seed-piece treatment would be of any benefit under the optimum germination conditions of this crop. These tests were also to ascertain whether a strong disinfectant such as acidulated mercuric chloride could be used under these favorable conditions without loss in stand or yield. Roccal was also included in these tests to determine whether the disastrous effects experienced in the tests with the Fall crop would be paralleled in the Spring. Because of difficulty in keeping the Zinc salts of the dithiocarbamates in suspension and indications that they would break down after several days in the vat, only a zineb dust was used. A similar compound, Vancide 51, however, was tested in several concentrations, with and without the sticker additive. The seed was cut and treated on February 25th and planted on February 27th in four blocks, each replication consisting of two rows, one quarter mile in length. These plots were harvested in June and yield data taken. The following average yields, expressed in 100 pound sacks per acre were obtained: check (no treatment), 211; 1 per cent Vancide 51, 202; 1 per-cent Vancide 51 plus sticker, 208; 5 per cent Vancide 51, 195; 5 per cent Vancide 51 plus sticker, 185; 0.2 per cent Roccal, 199; acidulated mercuric chloride (1:1000$HgCl^2$ + 1 per cent HCl), 217; 5 per cent zineb dust, 221. Statistical analysis of these results indicated that no treatment varied significantly from the non-treated check, demonstrating that, under the favorable conditions present at Spring planting time, seed-piece treatments are of little or no benefit with regards to yield and that strong disinfectants to control spread of disease can be used safely when the cut seed is planted soon after treatment.

Also in the Spring of 1952, Vancide 51 was tested for its bactericidal action in a plot of naturally infected ring rot potatoes. This test yielded one very important fact. Plots planted with diseased seed which had been dipped in a vat of 1 per cent Vancide 51 solution after diseased potatoes had passed through this vat for some time were compared with plots planted with untreated seed of the same source. The incidence of ring rot in the treated plots was very significantly higher than in the untreated plots. Average ring rot incidence in the four replications, as determined by the stem-ooze method (4) in the field, was 17.7 diseased plants per 100

feet of row for the treated plots compared with 6.5 diseased plants per 100 feet of row for untreated plots. A difference of 5.14 is necessary for significance at the 1 per cent level.

In the Fall of 1952 tests were undertaken to compare a 5 per cent zineb dust and a 1 per cent Vancide 51ZW dip with no treatment with regards to stand in the Fall crop. Vancide 51ZW, a Zinc salt of Vancide 51 was used because, in the laboratory it had compared favorably with other zinc dithiocarbamate products and remains in suspension very well. Seed was cut and treated August 18th, and planted with a picker type planter the next day in two one quarter mile rows per treatment, each replicated four times. Daytime soil temperatures were 60° to 70°F. One month later, stand counts were made with the following average number of plants found per 50 feet of row: no treatment, 55.6; 5 per cent zineb dust, 50.6; and 1 per cent Vancide ZW, 48.8. A difference of 3.33 is necessary for significance at the 1 per cent level and 2.47 at the 5 per cent level.

In separate plots the following treatments were also tested for their bacterial effectiveness in seed-piece treatment:

1. Check, no treatment
2. 0.2 per cent Roccal dip
3. 1.0 per cent Vancide 51 ZW dip
4. 1:500 $HgCl_2$ + 1.0 per cent HCl dip

Foundation seed stock was used in these tests. In more than 100 acres of potatoes planted from this seed in the same season, neither blackleg or ring rot was observed on a single plant proving the plants free of diseases used in this test. The source of disease organisms used in these tests was a group of several partially decayed potatoes which had been set aside the previous Spring because of their very typical ring rot symptoms and kept in cold storage until utilized in this experiment. Two separate tests were conducted, one to be known as the "Knife Inoculated Test" and the other as the "Dip Inoculated Test".

The knife inoculated potatoes were inoculated by drawing the cutting knife through a diseased tuber before cutting each seed potato. These seed pieces were then dipped in their respective treatments for one minute and set aside to be planted the next day. The purpose of this test was to determine whether the seed-piece treatments were able to reduce cutting knife transmission of the disease.

The dip inoculated potatoes were cut with disinfected knives then dipped for one minute in their respective treatments, to each of which had been added a slurry of the diseased potatoes, five minutes prior to the treatment. The purpose of this test was to determine whether bacteria were able to survive in any of these treatments long enough to infect seed-pieces dipped in them subsequently. In the case of the check, the slurry was poured in water and the seed dipped in it after five minutes.

The seed was cut and treated on September 15th and planted on September 16th by hand at 9" to 12" intervals, care being taken to prevent cross-contamination. Four replications of each treatment, each replication consisting of 50 seed pieces, were planted.

Since the tubers used for inoculum were chosen for their ring rot characteristics, this test was originally aimed at determining ring rot incidence for the various treatments. However, before substantial ring rot

foliage symptoms could appear the plants began breaking down with blackleg; hence, counts regarding the number of plants resulting from 50 seed pieces and the number of these possessing obvious blackleg symptoms in each replication were made. These results are shown in table 1. The results indicate very good control of cutting knife transmission of blackleg with acidulated mercuric chloride, fair control with Roccal, and an enhancement of transmission due to the Vancide 51 ZW dip. The dip inoculation results indicate that the disease organisms could not survive in any one of the dips except for a trace in the Vancide 51 ZW treatment.

These results also indicate acidulated mercuric chloride to be somewhat detrimental to stand. Consequently, under Fall planting conditions, this chemical may be too hazardous to use. It is also interesting to note that Roccal, which gave such adverse effects in the tests in the previous Fall crop, was not significantly detrimental to stand under the conditions of these tests.

TABLE 1.—*Knife inoculation and dip inoculation tests with healthy potato seed pieces inoculated with blackleg in the Fall of 1952. Two hundred seed pieces planted per treatment.*

| Treatment | Total No. Plants | Per cent Stand | Blackleg Plants Total No. | Blackleg Plants Per cent |
|---|---|---|---|---|
| Knife Inoculated Tests | | | | |
| Check—No Treatment | 151 | 75.5 | 44 | 29.1 |
| 1.0 per cent Vancide 51-ZW | 147 | 73.5 | 71 | 48.8 |
| 0.2 per cent Roccal | 137 | 68.5 | 16 | 11.7 |
| 1:500 $HgCl_2$+1 per cent HCl | 120 | 60.0 | 1 | 0.8 |
| Least Significant Difference—1 | | 13.7 | | 7.6 |
| 5 | | 9.6 | | 5.3 |
| Dip Inoculated Tests | | | | |
| Check—Water Dip | 158 | 79.0 | 34 | 21.5 |
| 1.0 per cent Vancide 51-ZW | 159 | 79.5 | 2 | 1.3 |
| 0.2 per cent Roccal | 164 | 82.0 | 0 | 0.0 |
| 1:500 $HgCl_2$+1 per cent HCl | 129 | 64.5 | 0 | 0.0 |
| Least Significant Difference—1 | | NS* | | 6.1 |
| 5 | | NS* | | 4.2 |

*No Significance

## CONCLUSIONS

Because these tests were conducted to find a single effective and practical seed-piece treatment, they cover too varied a field to present thorough data on any particular chemical, and further work needs to follow this preliminary testing. However, the results obtained present a number of interesting indications:

1. Laboratory testing demonstrated that many of the chemicals reported by workers in other areas to decrease seed-piece decay do not actually enhance the natural healing process, some being detrimental to it. Therefore, the reported decrease must be due to the action of these chemicals in combatting decay fungi. Field tests supported this evidence by indication that, in Kern County, most of these chemicals neither

decreased nor increased yield under favorable conditions and decreased stands under unfavorable planting conditions. This probably indicates an absence of the decay fungi as a problem in Kern County. Therefore, chemicals which injure the cut surface in any way may enhance decay due to bacterial or physiological causes.

2. Under the planting conditions of Kern County Spring potatoes strong disinfectants such as acidulated mercuric chloride may be used as seed-piece treatments without adverse effects if potatoes are planted within a day or two. Under the adverse soil conditions sometimes present in planting of Fall potatoes, however, results have shown that a severe treatment might be hazardous.

3. Results show that extreme care should be taken in selecting a seed-piece treatment if a dipping vat is used, since, when chemicals which are inadequate as bactericides are used, diseases such as ring rot or blackleg can be transmitted in the solution. Leach (9) demonstrated that chemicals which are ineffective against an organism can result in increased infection when they inhibit the natural laying down of a cork barrier between the source of infection and vascular tissues. This may be the cause for the increase of cutting knife transmission of blackleg experienced in the Vancide 51 ZW dip (Table 1) and may also be a partial explanation for the great increase of ring rot in the treated plots in the 1952 Spring tests.

4. Although seed-piece treatment cannot control systemic infection resulting from the use of naturally diseased tubers, it can be effective in controlling spread of blackleg and similar diseases to clean seed. These tests indicated acidulated mercuric chloride to be very effective in this capacity. This treatment, 1:500 $HgCl_2$ + 1.0 per cent muriatic acid when used as an instantaneous dip in the Spring crop, could replace the pre-cutting two-hour whole tuber soaking in corrosive sublimate now widely practiced in Kern County, when conditions permit planting soon after dipping.

5. The fact that a high percentage of blackleg infection resulted from inoculation with organisms from potatoes selected because of their ring rot symptoms indicates that the blackleg pathogen, *Erwinia atroseptica* (van Hall) Jennison, may be present as a secondary organism to other diseases. This has also been demonstrated by Bonde (1) who found the blackleg bacteria to be present in seed pieces affected with *Phoma tuberosa* Melhus *et. al.* and further showed that blackleg could be transmitted to clean seed by the cutting knife from such a secondary infection.

## Acknowledgments

The author gratefully acknowledges the assistance of Dr. W. D. McClellan in the preparation of this paper and the advice of Dr. John W. Oswald in various portions of these tests.

## Literature Cited

1. Bonde, Reiner. 1950. Factors affecting potato blackleg and seed-piece decay. Maine Agr. Exp. Sta. Bull. 482.
2. Elmer, O. H. 1942. Prevention of potato seed-piece decay. Amer. Potato Jour. 19: 19-23.
3. Frear, D. E. H. 1953. Pesticide Handbook. College Science Publishers. State College, Pa.

4. Korr, L. C. 1945. Reliability of stem-ooze test. Amer. Potato Jour. 22: 57-62.
5. Lane, G. H. 1950. Studies of potato seed-piece rot (abstract). Colo.-Wyo. Acad. Sci. 4: 57.
6. ————. 1952. Studies of dry fungicides on cut potato seed piece (abstract). Phytopath. 42: 25.
7. Newton, W. 1952. Effects of the application of fungicides to wounded plant tissues. Sci. Agr. 32: 659-662.
8. ————. and C. Lines. 1947. The dusting of cut potato tubers as a preventative against Pythium rot. Sci. Agr. 27: 72-73.
9. Leach, J. G. 1927. The nature of seed-piece transmission of potato blackleg. Phytopath. 17: 155-160.
10. Olmstead, D. S. 1952. Effects of seed-piece treatment on yields and seed-piece decay of potato (abstract). Phytopath. 42: 26.
11. Rich, A. E. 1952. Fungicidal treatments of seed potatoes after cutting (abstract). Phytopath. 42: 26.
12. Sanford, G. B. 1949. Prevention of early decay of cut potato sets by chemical treatment. Sci. Agr. 29: 345-350.
13. ————. 1951. Effect of various chemicals to the natural healing of freshly cut potato sets. Phytopath. 41: 1077-1082.
14. Tucker, J. and E. W. Harper. 1933. Seed treatment for blackleg control. Sci. Agr. 141: 70-72.
15. Young, R. A. and J. A. Milbrath. 1952. Control of potato seed-piece decay by seed-piece treatment (abstract). Phytopath. 42: 26.

## POTATO NEWS AND REVIEWS

# NEW DEVELOPMENTS IN POTATO HANDLING MACHINERY[1]

T. J. Lockwood[2]

It is generally thought that some one in machinery business thinks up a new idea and then produces it for the potato industry; we do not believe this is true. From the potato grower to the consumer, the potato industry is so closely related that any little change in one place calls for changes on down the line. There was almost no change in the potato industry in America until 1930; the rest of the world has not yet made the change; Europe is just now in the planning stage for new merchandising policy.

I believe that the high cost of freight alone had more to do with changing the potato industry than any other factor. Next came the machine age for farming, and competition from other fruits, then the ice box and also the small apartment type of living.

Idaho, Nebraska and Colorado were among the first to start making changes in handling potatoes. They were a long way from market, so had to do something better to get the eastern market.

### Grader Developments

The shaker grader was the type first used (it is still the only grader in South America, Europe, and Africa). It was needed because potato growers could not afford to ship dirt and defective tubers together with marketable potatoes. This then made a demand for sacks, because growers could afford to handle them that way. This did not call for changes in harvesting, as long as the crop was grown only by small growers.

The grading of potatoes eventually created a new industry and by establishing some grade standards for government inspection, buyers were able to handle potatoes as a commodity rather than just a truck-farming product. Therefore, it was not long before grading and inspection was an established practice, and in order to market a more attractive product, some growers in the potato producing areas located far from the terminal markets, took another step — the washing and drying of potatoes. (Figure 1).

The washing of potatoes is a comparatively simple operation and was therefore quite generally accepted by the industry. Only those areas located close to market and having a freight advantage were able to sell their product without washing. However, during the first low price year following this development, it was discovered that the washing operation revealed considerable bruising. This bruising was particularly accentuated by efforts on the part of growers to increase their yields through large applications of chemical fertilizers and by digging the crop early (usually long before maturity) in order to hit the best markets. This development forced the industry to look for new equipment to handle the potatoes better.

[1]Accepted for publication March 15, 1954.

[2]President, Lockwood Graders, Inc., Gering, Nebr.

FIGURE 1.—Portable washer, drier and waxer.

## HARVESTING EQUIPMENT

Diggers had not changed much except from single- to two-row machines and growers were planting more acreages. The most important machine to enter the field at this time was the vine beater. Because of the large vine growth, and the necessity to clear the field for early digging, this machine was absolutely essential. Together with the vine beater came the burners and chemicals; however, the vine beater still takes the lead. Because of pressure from the growers, we have made many improvements on the beater. A few of these include (1) a rubber-covered top, so mud will not build up and add weight to machine or wear out beaters; (2) iron beaters have been designed and mounted so that all of the cut vines are left on top of the row, this will protect the potatoes from sun or frost and permit the easy operation of two-row diggers; (3), press wheels were added on back to keep the machine just the right height above the ridge. The beaters also close up cracks in the soil thus further preventing burning and frost damage in addition to breaking up many clods.

## CONSUMER PACKAGING

By growing better potatoes and grading properly, it was desirable for the shipper or buyer to put his own name on the packages. This helped create the consumer pack, because potatoes would keep longer, homes were smaller, and competing fruits and vegetables were being put on the market in much better condition.

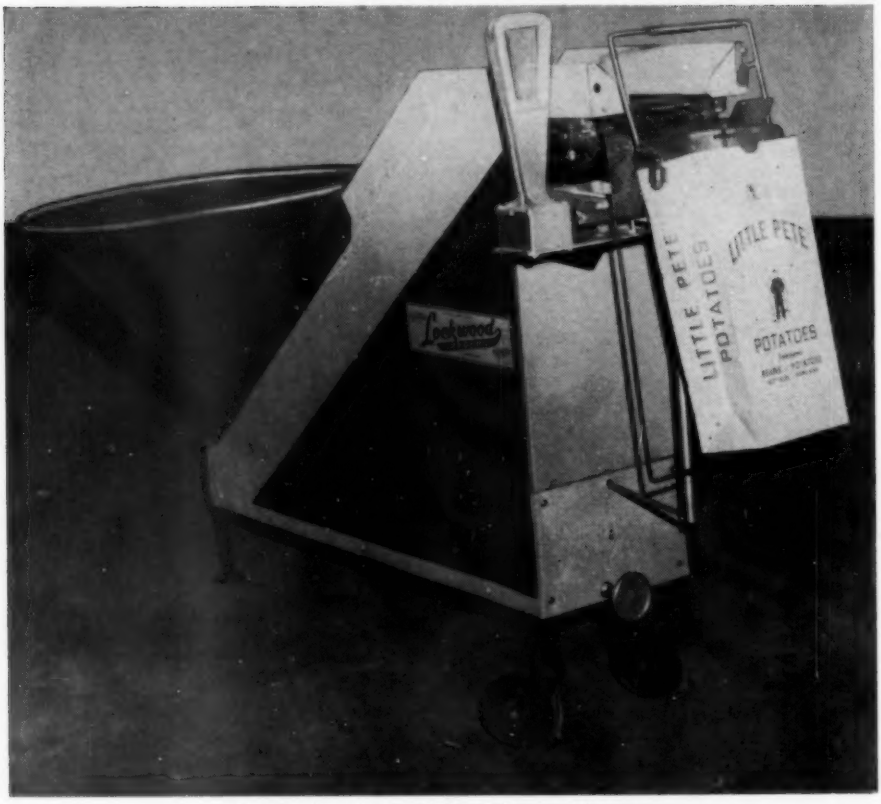



FIGURE 2.—Automatic weigher and bagger.

There are many makes of pre-packaging machines on the market and they are getting better and cheaper every day (Figure 2).

Because of generally good profit through increased yields, one of the most important changes was elimination of waste between shipper and consumer. We believe the statement that potato consumption has decreased a great deal is only partially true, because consideration is not given to the condition of the potato marketed today as compared with 40 years ago.

## SIZERS DEVELOPED

However, scarcely had the use of the small package come about, when it was found necessary to size, to put the correct size in small packages and send larger sizes in 100-pound bags. This demand created four different types of sizers, and each one is very good in its place and price range. The screen sizer is used in most cases to take out the large potatoes; then the stationary spool sizer, the adjustable spool sizer, and now the Kerian sizer, which seems to fit the need for almost all conditions, with the necessary conveyor belts to sack the potatoes. (Figure 3). The Kerian sizer uses revolving rubber rolls, which gradually become more

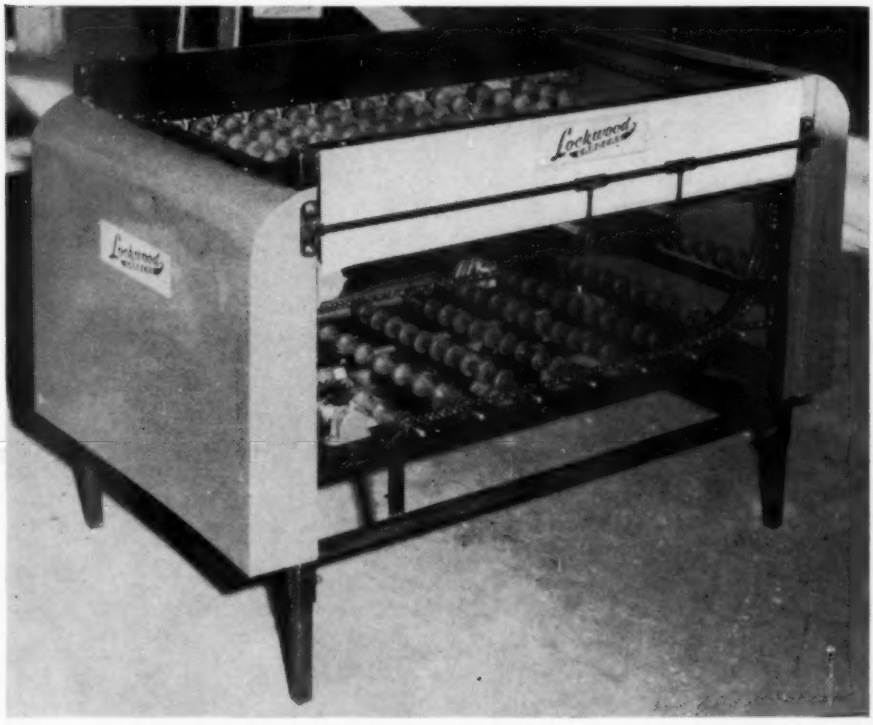



FIGURE 3.—Potato sizer using turning rubber rolls of varying sizes.

widely separated as the potatoes move over the unit. By simple adjustment, it is possible to eliminate any size desired.

## WAXING DEVELOPED

The cleaned and sized potato then made it possible to add wax. In the red-potato industry, it has been widely used. However, almost from the first it was necessary that potatoes be partially dried before applying the wax. The drier also made it possible to do a better job of merchandising in small packages. In areas where heat driers were not in use, this was taken care of very well with a wringer-roller type of drier, and it has been found that foam rollers are generally the best; however, wool blanket rollers are used quite extensively. The waxer was either built in with this unit or as a separate machine, but it consisted of hair brushes with an overhead applicator. Now nearly all users have the drip method, which is a mechanical attachment to spread wax on a large brush. Waxing potatoes has not been used very extensively because the potato was a cheap item compared with apples, cucumbers, and most of the fruits and vegetables which are waxed. Also, at the start the wrong wax was used, which had no value for preserving potatoes. Now, however, with most shippers having washers and many having small driers, it will be a simple operation to wax the potatoes. The little

cost of waxing them is profitable when a simple cheap paraffin base wax is used. We believe that the potato can be waxed for one cent per hundredweight, and it will show a resulting profit varying from two to six cents, on the average, and in a few cases much more. Clear wax may be used on any type of potato, and with the addition of a sprout inhibitor in the spring of the year, it will take care of those being stored in warm stores instead of in basements.

## Conveyors

We, as well as other manufacturers, have built conveyors to fit individual problems, and it is now almost a universal practice to run potatoes over a chain-type conveyor which will eliminate dirt prior to going into storage. However, where there are new warehouses, or old ones equipped so that trucks can be driven into each bin, handling, at storage time, is no problem. The self-unloading box with conveyor in bottom which is used either with harvester, or field bulk loaders, is the complete answer for bulk handling at storage time, and beyond that point it is just a case of getting a standard bin filler large enough to fit the storage. Practically all new warehouses are being built to handle potatoes in bulk according to this plan.

## Harvesters Developed

Many large growers have found that they had enough potatoes to maintain a washing plant and handle their own crop, but they had too many potatoes to harvest by the old method. Building harvesters looked like a profitable business, therefore many shops and growers started to build them. (Figure 4). Most of these machines, however, were too large and too complicated, so steady improvements are now being made. First, nearly every one wanted a harvester which would dig, clean, and convey the potatoes to the truck in one operation. Today the trend is to do more to prevent the potatoes from being bruised. In most cases, potatoes are dug first, and allowed to dry for a short period, and then picked up with the harvester. This method enables the smaller grower to mechanize his potato handling in a piece-meal manner, permits operation under varied conditions and allows him to use his digger where he could not use a harvester at all. It has generally been found that there is less bruising with a harvester than with hand picking. However, we believe this is true because the growers have a smaller crew and better men who are interested in the potatoes. Bulk handling into the warehouse is much better than any type of hand and sack method.

The next big step in harvesting will be the self-propelled harvester, which is needed very badly for small fields. We believe this year there will be several standard makes on the market. We have made one, simple and cheap enough so that the man who has a small acreage can afford one and the large grower can have several.

## Eliminating Clods

The harvester presents another problem which must be solved and that is the condition of the soil. In the past, a few clods and rocks

FIGURE 4.—Potato harvester with bulk loader.

were hardly considered an obstacle; now, we find, with better farming practices, many of the clods can be eliminated before harvest, and more effort will be put into removing rocks from potato fields. Humus in the soil is one of the most important considerations to permit successful harvester operation. Heavy applications of chemical fertilizers tend to make the soil very cloddy, particularly in dry seasons, and in many areas the harvester will not work, unless the soil is moist. In some cases, however, sprinkler and ditch irrigation are being used ahead of harvester. This not only lets the harvester work better but less clods mean less bruising even for hand operations.

## VINE PULLERS

Then with the harvester in general use another problem appeared — and that is when potatoes are dug and harvested in one operation, and cannot be left on top of the ground for the skin to get set, there may be more skinning and in some cases more bruising. The answer to this problem lies in the complete removal of the vines, since it has been found that the vine beater does not mature potatoes as well as had been expected. Under some conditions it causes the stem end of the tubers to blacken when a large vine is cut off in hot weather and the sap from roots goes into the tuber too fast. The vine puller eliminates vines with a combination pulling and shredding mechanism. A great deal of developmental work has been done on the vine puller, but they have had many mechanical faults. As the demand for harvesters increases these faults will be overcome and the benefits gained will outweight the remaining faults. Most of the work on these machines has been done in Idaho, but last year they were tested in many areas, and construction faults showed up under various conditions. This year, however, they have been corrected, and the machine will work under most conditions. (Figure 5). However,

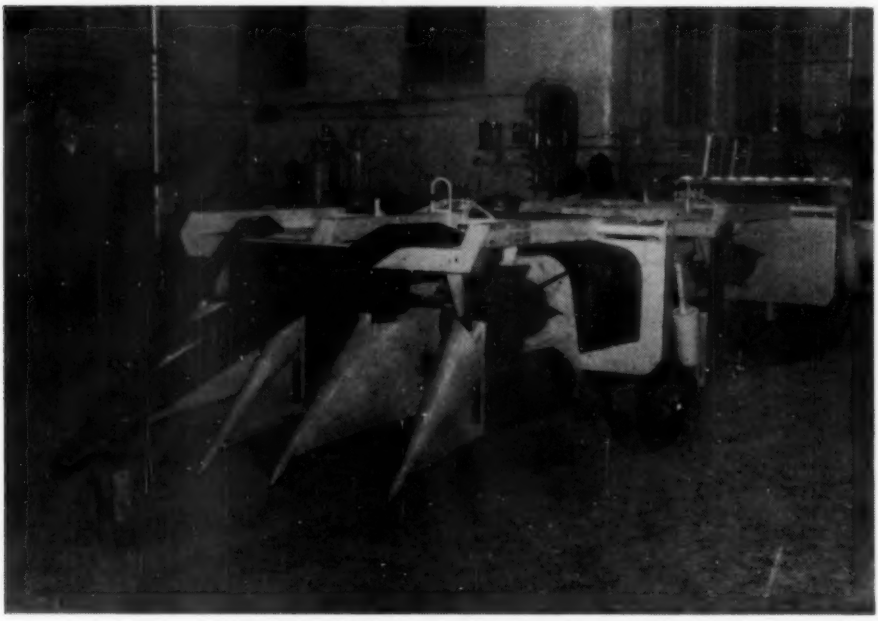


FIGURE 5.—New type vine puller.

cultural practices will have to be slightly changed to allow for an efficient puller operation. This can be done by regulating the size of the ridge, planting deeper, and having wider rows so that more dirt is available to cover the tubers.

In Holland, thousands of acres of potato vines are pulled by hand. This is done on their seed plots to control the size, and stop any disease which normally attacks the tuber as it matures. In Alaska, vines in many fields are pulled by hand to ripen the crop so the harvest can be complete before frost.

If blight hits a field which is about ready for harvest, it is possible to pull the vines and keep the disease from entering the tuber, and thereby save the crop. Also, during early summer harvest, pulling the vines will hasten maturity so the crop can be put on the early market a week to ten days earlier.

The advantages of using the puller are many, but most of them do not show until the potatoes are being removed from storage in the spring. It takes a very good operator, and it is an expensive, heavy machine, so the general use of the puller will be slow.

## NEW DIGGER NEEDED

There has been very little change in the standard digger during the past 30 years, and the industry is in need of a new and better machine. We have built a tractor-mounted digger, and it works very satisfactorily under normal conditions, but it fits only one make of tractor, so it cannot be considered an improvement for the industry.

It is much harder to make an improvement than it seems. It must be something cheaper and better, but most important it must also fit in with the present operation. Our new type chain which will fit any digger without any changes makes it possible to say it is universal. The features that the chain has are made to fit the demand of new harvesters. Rods are bent so that potatoes roll to the center away from the sides, and they will not carry so much dirt forward under the digger as does the standard chain, which causes the potatoes to be pushed out. It does not have a high link behind the blade to hit the potatoes, and has an extra bend on the side to increase wear.

There is a new type of shaker digger in use in Germany. It was first built in 1939, and then during the war nothing was done. I saw this machine in operation at a harvester contest in England in 1952, and met the man who invented it. His plant was in east Germany. He spent three years in prison after the war, and his plant was taken over. It is now starting again in Essen, Germany. I talked with their factory representatives on my last trip, and we are trying to make arrangements to bring one to this country. It may be an improvement in some of our districts. This machine has no chains or sprockets on it.

## New Packaging Materials

With the use of small packaging at shipper level the mesh bag was most popular and paper bags were next. Not only were the small packaging units needed, but methods for closing the bags were also needed. This has been worked out very satisfactorily with wire-locking machines and sewing or stapling machines. This equipment on the shipper level soon developed to such an extent, and the demand became so great for this type of package that it was possible for some plants to be set up in large cities to wash, pre-pack, and deliver directly to retail stores.

Another new development is coming; and it is the use of the polyethylene bag. This is what the customer wants, and since it has the advantage of being filled on the market-end rather than the shipper-end, it has created a demand for a small, cheap bagger for large chain stores and produce markets. The shippers are prepared to give them just the potato they want for this operation — the right size, washed and waxed.

There have been many changes in handling potatoes during the past 15 years, but we feel it is because the industry was so far behind at that time, and those in the potato industry, whether grower, merchandiser, or machinery manufacturer, can look with pride to the fact that their industry is now equal to any in giving the customer what he wants. There will be many changes in the future, but we do not believe they will take place so rapidly for a while.

## Summary

In outlining the general changes in equipment, the most important thing to remember is that each part of the industry is very closely related to the other. Any improvement in one helps the other, even though it seems like a new problem at the time.

We in the equipment field, can not take credit for the new ideas on what is needed, but we are ready to develop and put on the market at reasonable price, equipment that will fill the needs of a new operation.

# PROGRAM OF THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA

## August 25, 26, 27, 1954

## Estes Park, Colorado

### Wednesday Morning, August 25, 1954

### Colorado Room, 9:00 A.M.

**Session 1**

L. A. SCHAAL, **Chairman**

9:00 — 1. **Certified Seed Potato Control Areas in British Columbia, Canada.** H .S. MAC LEOD, Division of Plant Protection, Vancouver, B. C., Canada.

9:15 — 2. **Resistance of Potatoes to *Verticillium albo-atrum*.** J. H. MUNCIE, Michigan State College, East Lansing, Mich.

9:30 — 3. **The Inhibitory Effect of Phenolic Compounds on the Growth of *Streptomyces scabies* in Culture Medium.** L. A. SCHAAL, USDA and G. JOHNSON, Colorado A. & M. College, Fort Collins, Colo.

9:45 — 4. **The Reactions of Four Species of Potato-Infesting Aphids to Insecticidal Treatments.** D. D. POND, C. A. MOORE and J. B. ADAMS, Field Crop Insect Laboratory, Fredericton, N. B., Canada.

10:00 — 5. **Some New Findings Concerning *Phytophthora infestans*.** J. L. HOWATT and P. N. GRAINGER, Dominion Laboratory of Plant Pathology, Fredericton, N. B., Canada.

10:15 — 6. **Blondy, A Yellow-Green Somatic Mutation in the Chippewa Potato.** G. H. RIEMAN, D. C. COOPER and D. A. YOUNG, University of Wisconsin, Madison, Wis.

10:30 — 7. **Anomalous Tuberization of *Solanum tuberosum*.** H. O. WERNER, University of Nebraska, Lincoln, Nebr.

10:50 — 8. **Selection of Desirable Somatic Mutations, A Means of Potato Improvement.** J. C. MILLER, Louisiana State College, Baton Rouge, La.

### Wednesday Afternoon, August 25

### Colorado Room, 1:30 P.M.

**Session 2**

C. E. PETERSON, **Chairman**

1:30 — 1. **Enhancing Blooming by Preventing the Formation of Tubers.** H. O. WERNER, University of Nebraska, Lincoln, Nebr.

1:35 — 2. **Pollen and Pollination Studies on Irish Potatoes.** J. R. KING, Louisiana State University, Baton Rouge, La.

1:55 — 3. **The Effect of Pollen Aging on Seed Development in *Solanum*.** KATHERINE BEAMISH, University of Wisconsin, Madison, Wis.

2:10 — 4. **A Tissue Culture Method of Studying the Potato Plant.** HAROLD CHAPMAN, University of Nebraska, Lincoln, Nebr.

2:25 — 5. **The Use of Foreign Introductions in the Breeding of U. S. Potato Varieties.** R. W. HOUGAS and R. W. ROSS, University of Wisconsin, Madison, Wis.

2:40 — 6. **Selection of Greenhouse-Grown Seedling Potatoes Based upon Specific Gravity and Tuber Characters.** C. E. PETERSON, Michigan State College, East Lansing, Mich.

2:55 — 7. **Four Red and One White Variety from the Nebraska Potato Breeding Program.** H. O. WERNER and ROBERT O'KEEFE, University of Nebraska, Lincoln, Nebr.

## Wednesday Evening, August 25

### Dinner — 6:30 P.M.

### Announcement and Presentation of 1954 Honorary Life Members

## Thursday Morning, August 26

### Colorado Room, 8:30 A.M.

S. B. LOCKE, **Chairman**

### Joint Session with the American Phytopathological Society

#### Session 3

9:00 — 1. **A Study of *Corynebacterium sepedonicum* of *Solanum tuberosum* as Related to Host Resistance and Spread by Water.** GORDON ARNOLD, University of Wyoming, Laramie, Wyom.

9:10 — 2. **Effect of Temperature on the Development of Ring Rot.** C. E. LOGSDON and C. J. EIDE, University of Minnesota, St. Paul, Minn.

9:20 — 3. **Distribution of Races of *Phytophthora infestans* (Mont.) de Bary in Canada.** K. M. GRAHAM, Science Service, Department of Agriculture, Ottawa, Canada.

9:35 — 4. **The Flagella of Swarmspores of *Phytophthora infestans* (Mont.) de Bary as Viewed with the Phase and Electron Microscopes.** VIRGINIA R. FERRIS and H. H. LYON, Cornell University, Ithaca, N. Y.

9:50 — 5. **Histological Study of Suscept-Pathogen Relationships between *Solanum demissum* Lindl. derivatives and *Phytophthora infestans* (Mont.) de Bary.** VIRGINIA R. FERRIS and L. C. PETERSON, Cornell University, Ithaca, N. Y.

10:00 — 6. **Differential Reaction of Potato Hosts to Foreign and Domestic Physiologic Potato Races of *Phytophthora infestans*.** R. PRISTOU and M. E. GALLEGLY, West Virginia University, Morgantown, W. Va.

10:10 — 7. **The Interrelationship of Potato and Tomato Races of *Phytophthora infestans*.** J. B. WILSON, West Virginia University, Morgantown, W. Va.

10:20 — 8. **Northern Peru, A Possible New Source of Potatoes Resistant to *Phytophthora infestans*.** C. OCHOA, University of Minnesota, St. Paul, Minn.

10:35 — 9. **Parasitic Aggressiveness and Its Relation to Late-Blight-Tolerant Potato Varieties and the Survival of the Pathogen.** ALFONSO CASTRONOVO, H. D. THURSTON and C. J. EIDE, University of Minnesota, St. Paul, Minn.

10:50 — 10. **Vector Feeding Relative to Leafroll Resistance in Potato Varieties.** S. B. LOCKE, Washington State College, Pullman, Wash.

11:00 — 11. **An Association of Late-Breaking Virus in Potatoes with a Phyllody Condition in Ladino Clover.** W. B. RAYMER and C. R. AMEN, Oregon State College, Corvallis, Oreg.

11:15 — 12. **The Apparent Graft Transmission of a Factor Causing Tuber Formation in Potatoes.** L. E. GREGORY, University of California, Los Angeles, Cal.

## Thursday Afternoon, August 26

## Colorado Room, 1:30 P.M.

### Session 4

### H. O. WERNER, Chairman

1:30 — 1. **The Technology of Potato Granule Manufacture.** R. L. OLSON and W. O. HARRINGTON, Western Utilization Research Branch, U.S.D.A., Albany, Cal.

1:45 — 2. **Better Quality French Fried Potatoes.** MARY E. KIRKPATRICK, Human Nutrition Research Branch, U.S.D.A., Washington, D. C.

2:15 — 3. **The Variation of Reducing Sugar Content in Different Varieties of Potatoes.** A. WATADA and R. KUNKEL, Colorado A. & M. College, Fort Collins, Colo.

2:30 — 4. **Storage Research with the Newly Constructed Storage at the Scotts Bluff Experiment Station.** H. O. WERNER and LIONEL HARRIS, University of Nebraska, Lincoln, Nebr.

2:55 — 5. **The Effect of Periodical Potato Top Removal on Yields.** K. C. WESTOVER, University of West Virginia, Morgantown, W. Va.

3:10 — 6. **Turgidity Cycle in Potato Leaves Throughout a 76-Hour Period.** J. A. RIDDELL and H. O. WERNER, University of Nebraska, Lincoln, Nebr.

3:25 — 7. **The Effect of Maleic Hydrazide and 2,4-D on Reducing Sugars and Sucrose of Red McClure Potatoes.** MERLE G. PAYNE, JESSE FULTS, DOROTHY FARHNAM WARD, and GRACE KIYO YASUDA, Colorado A. & M. College, Fort Collins, Colo.

## Friday Morning, August 27

## Colorado Room, 8:30 A.M.

### Business Meeting

J. W. SCANNELL, **President, Presiding**

# The POTATO
## IN HEALTH AND DISEASE

**A new monograph indispensable to the**

**FARMER** **STUDENT**
**SCIENTIST**
**SALESMAN** **SEEDSMAN**

*3rd Ed. Revised & Enlarged 760 pp.*

**$9 POST FREE**

**Payment on Receipt of Invoice**

BRITISH BOOKS ARE CHEAPER

Please send me ..... cop(y(ies) of *The Potato in Health and Disease*

Name .....

Address .....

.....

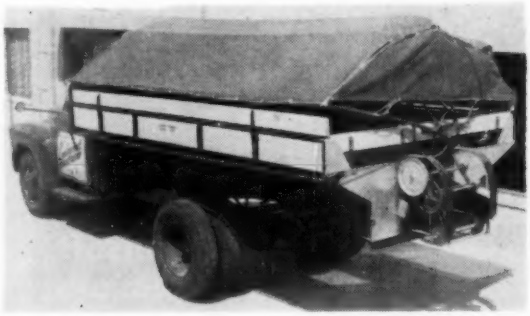
Send your order for this and all agricultural books to:

**JAMES THIN**
53-59 South Bridge, Edinburgh, Scotland.

DIRECT BANKING ARRANGEMENTS IN U. S. A.

Stop the Market with Lockwood GRADER CORP. GERING, NEBR.

# SAVE THOSE POTATOES
# USE A LOCKWOOD
# ROLL AWAY BOX COVER



- **Stop Wind Burn.**
- **Stop Sun Scald.**
- **Prevent Freezing in Winter.**

**MODEL NO. PBC-14**

Don't Delay—Write Today For Equipment Bulletin #204

Rupert, Ida. Monte Vista, Colo. **LOCKWOOD GRADERS CORP.** **Gering, Nebr.** Grand Forks, N. D. Antigo, Wis.

# DOUBLE USE
# DOUBLE STRENGTH

Use PENCO PENITE 6X* and harvest potatoes faster! PENCO PENITE 6X* kills and dries up the thick growth that clogs the digger. You also get better yield because potato skins are tougher, less subject to mechanical injury. PENCO PENITE 6X* is a concentrated double strength product containing equivalent 9.5 lb./gal. of arsenic trioxide. You buy the *active* material . . . not a diluted solution. Merely add water to make a fast-acting spray-type potato top killer. Just one application does the trick. Economical, too, because PENCO PENITE 6X* is *concentrated!*

**PENCO PENITE 6X* — at your local farm supply dealer in handy five gallon tins**

PENCO*® Agricultural Chemicals

**PENNSYLVANIA SALT MANUFACTURING CO.**
**OF WASHINGTON**
TACOMA 1, WASHINGTON

Philadelphia 7, Pa., Montgomery, Ala., Bryan, Tex., Portland, Ore., Los Angeles and Berkeley, Calif.

**Pennsalt Chemicals**

*PENCO and PENITE 6X registered.

# SUCCESS

## *belongs to specialists!*

**YOU** SPECIALIZE IN POTATOES!

**WE** SPECIALIZE IN POTATO FERTILIZERS!

For 32 years, The Summers Fertilizer Company has supplied many of the largest potato growers in America with their plant food requirements. This record of specialized success is your best reason to . . .

**USE SUMMERS "BEST-ON-EARTH"**

# FERTILIZERS

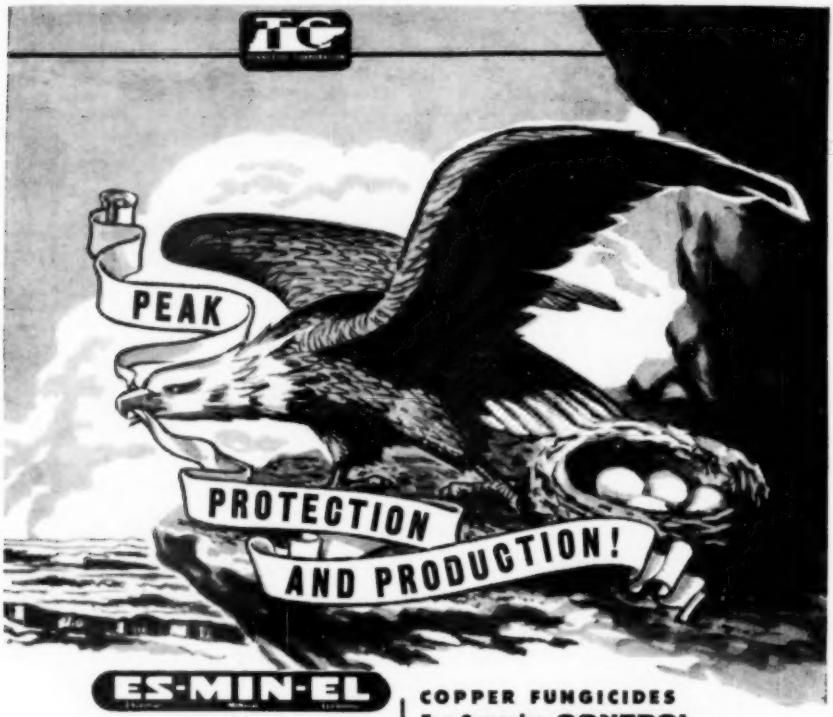
"The difference is in the formula"

# SUMMERS

## FERTILIZER CO., INC.

Totman Bldg.

**210 E. Redwood St.** **Baltimore 2, Maryland**




## ES-MIN-EL

SOIL APPLICATION

### FOR INCREASED PRODUCTION!

**In order to produce healthy plants and vitamin-rich crops, your soil must have the proper mineral balance. Perfect health in plants, as in the human body, requires minerals. You cannot grow crops rich in vitamins in soils that are lacking in minerals. Es-Min-El contains the essential minerals — Zinc, Copper, Manganese, Boron, Iron, and Magnesium. Mineralize your soil now with Es-Min-El for healthiest plant growth and vitamin-rich crops.**

Es-Min-El is now available in spray or dust form. If you haven't mineralized your soil you can now feed these minerals to your plants through the leaves and stems. Es-Min-El spray or dust is a neutral form of Copper, Manganese and Zinc.

**SOLUBLE TRACE MINERALS**

Tennessee's trace minerals are soluble and their nutritional value is immediately available to the plant. Soluble trace-minerals are more economical and faster acting.

REQUEST: That your local fertilizer dealer furnish you a completely mineralized fertilizer containing the essential mineral elements.

## COPPER FUNGICIDES *For Superior* CONTROL *And* PROTECTION!

**The most effective control of blight and other persistent fungus diseases is assured by TC copper-based fungicides. Get an edge on blight by using copper before it attacks your growing crops. As basic producers of copper, the Tennessee Corporation produces a copper-based fungicide to meet virtually every need. Their application is simple and safe. Spray with these superior fungicides early and late and reap greater yields of better quality crops.**

**TRI-BASIC**

TRI-BASIC Copper Sulphate is a chemically stable copper fungicide containing not less than 53% metallic copper. TRI-BASIC Copper Sulphate can be used as a spray or dust on practically all truck crops and citrus crops. Control persistent fungus diseases — correct copper deficiencies from a nutritional standpoint. Use TC TRI-BASIC Copper Sulphate.

TRI-BASIC COPPER SULPHATE

**COP-O-ZINK**

COP-O-ZINK is a new, neutral copper-zinc fungicide containing 42% copper and 11% zinc. COP-O-ZINK gives superior performance in control of fungus diseases. COP-O-ZINK'S composition of two essential elements gives it added value in correcting deficiencies of zinc and copper and in stimulating plant growth. COP-O-ZINK is compatible with all inorganic and organic insecticides. No lime is required. For use in spraying or dusting.

**MICROGEL**

MICROGEL contains 50% copper as metallic and is chemically stable. Can be used most effectively on all truck crops — also grapes, citrus fruit, melons and strawberries. Microgel is simple to use. It can be added directly to spray tanks, saving time and labor.

"MICROGEL"

REQUEST: That your local dealer furnish you Tennessee TRI-BASIC Copper Sulphate when buying Copper dust mixtures

TENNESSEE TC CORPORATION

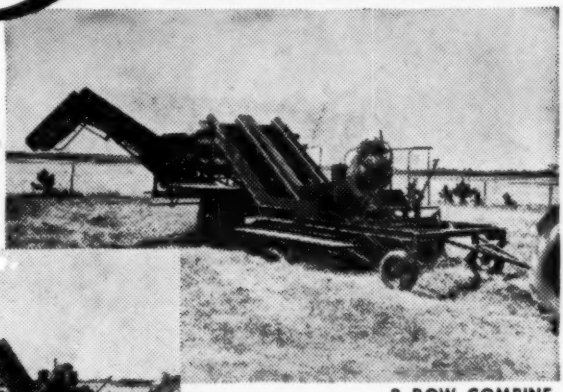
617-39 Grant Building, Atlanta, Georgia

# MECHANICAL HARVESTING *at its best!*

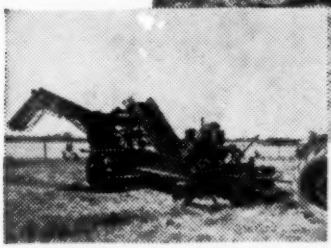
The Amazing New

## 1955 DAHLMAN POTATO COMBINE

GET THE FACTS
ASK FOR NEW
**FREE**
LITERATURE



2 ROW COMBINE



1 ROW COMBINE

## *NOW*...12 GREAT NEW FEATURES

1. DOUBLE ADJUSTABLE SIDE DELIVERY APRON
2. INCREASED CLEARANCE BENEATH FRAME
3. INCREASED TIRE SIZE
4. EXPANDED WORKING AREA
5. LARGER CLOD ELIMINATOR
6. OFFSET HYDRAULIC PUMP
7. OPEN THROAT FRONT END ON 32" DOUBLE ROW
8. REDUCED LENGTH FOR SHORTER TURNING
9. EXTRA HEAVY DIGGER SIDE PLATES
10. SEALED BALL BEARINGS ON SIDE DELIVERY APRON
11. HYDRAULIC STEERING ON BOTH MODELS
12. IMPROVED APRON DRIVE MECHANISM

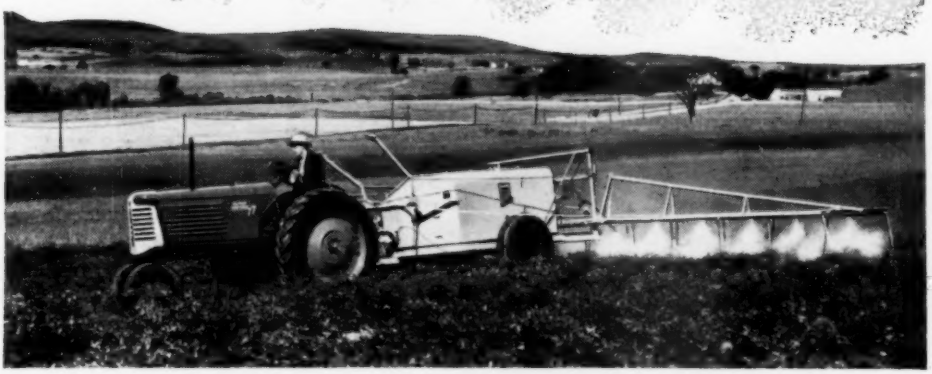
THESE, AND MANY OTHER OUTSTANDING ADVANCEMENTS, MAKE DAHLMAN EQUIPMENT THE FINEST MONEY CAN BUY

**DUAL MANUFACTURING & SALES COMPANY**
**293 Snelling Ave. N., Box 5066, St. Paul 4, Minn.**

University Microfilms
313 North 1st St
Ann Arbor Michigan


## Protect Your Potato Crop

# SPRAY THE IRON AGE WAY



## Here's why you get more coverage at lower cost with IRON AGE

**LISTEN** to what potato growers say about spraying the Iron Age way: "I sprayed over 155 acres the full season without putting a wrench to my pump"... "Iron Age saves me money because I never have *any* pump trouble" . . . "Get better coverage with Iron Age than any other sprayer I've seen" . . . Iron Age performance pays off, because Iron Age builds sprayers in sizes and capacities to meet every potato grower's demand for a machine that delivers maximum coverage with low upkeep. The famous Iron Age pump maintains high pressures needed, and still takes a beating season after season without breakdowns. See your Oliver Iron Age Dealer about the model you need to insure top profits on your potato crop.

***For complete information*** **write today to: THE OLIVER CORPORATION, Dept. 01, 400 W. Madison Street, Chicago 6, Illinois.**

OLIVER
IRON AGE

*Finest in Farm Machinery*

***PLANT AND SPRAY . . . THE IRON AGE WAY***